INDUSTRIAL HYGIENE SURVEY REPORT

at

Kaiser Aluminum & Chemical Corporation
Chalmette Works
P.O. Box 1600
Chalmette, Louisiana 70044

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Industrial Hygiene Section
Industrywide Studies Branch
Division of Surveillance, Hazard Evaluations and Field Studies
National Institute for Occupational Safety and Health
Centers for Disease Control
Cincinnati, Ohio

PURPOSE OF SURVEY:	To conduct industrial hygiene survey of employees working in selected aluminum reduction operations to ascertain exposure to polynuclear aromatic hydrocarbons and nuisance dust.
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STANDARD INDUSTRIAL CLASSIFICATION OF PLANT:	3334
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INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) is engaged in a study of worker exposure to airborne concentrations of polynuclear aromatic hydrocarbons (PAH) in the aluminum reduction industry. Organic materials used in making anodes and cathodes, when heated during materials blending and during the aluminum reduction process, are sources of PAH compounds. Several PAH compounds identified in air pollution studies in selected major cities and in studies of coke oven workers have been shown to induce skin cancer and lung cancer in laboratory test animals.[1]

The study is divided into two parts--epidemiology and industrial hygiene. The epidemiologic evaluation is a case-control study of lung cancer mortality using personnel records from 13 aluminum reduction facilities, while the industrial hygiene evaluation will characterize worker exposure to several PAH compounds at four of the 13 plants. A composite report for each part as well as individual industrial hygiene reports for each plant will be written.

This paper is a report of the industrial hygiene evaluation at one of the four facilities--Kaiser Aluminum and Chemical Corporation, Chalmette, Louisiana. Results of measurements made for five PAH compounds, for the benzene soluble fraction of coal tar pitch volatiles, and for nuisance dust are reported.

DESCRIPTION OF FACILITY AND WORKFORCE

The Kaiser-Chalmette, Louisiana Works was built in 1951. This location was chosen primarily because of economically available electrical power needed for aluminum reduction. Molten aluminum is produced in reduction cells--more commonly referred to as pots--which are located in the potroom. Supporting the potroom operations are a carbon plant (where organic materials needed for aluminum reduction are prepared), a powerplant, and a materials handling system which stores and subsequently transfers raw materials to the pots. The metal castings department casts molten aluminum (obtained from the potroom) into a variety of forms--extrusion billets, redraw rods, etc.

Approximately 2,600 people are employed at the Chalmette Works of which about 2,000 are production employees. Approximately 1,000 of these workers are employed in the potroom.

DESCRIPTION OF PROCESS

Kaiser-Chalmette uses the horizontal Soderberg electrolytic process to extract aluminum (Al) from alumina (Al_2O_3). In the Soderberg process, the alumina is dissolved in a molten bath of cryolite ($AlF_3 \cdot 3NaF$) along with other additives, then electrolytically reduced to aluminum by passing electric current from a carbon anode to a carbon cathode in the pot.

The pot is composed of two sections: a substructure which contains the carbon cathode material; and a superstructure which contains the carbon anode material. Also included as part of the superstructure are the side doors, frame, material bins and exhaust hooding. See Figure 1. The electric current--70,000-80,000 amperes at a 5 volt potential--separates the aluminum and oxygen ions. The oxygen liberated combines with carbon contained in the anode to form carbon dioxide. Lesser amounts of carbon monoxide are also formed. The aluminum settles to the bottom of the pot. The molten metal is then periodically syphoned off into a crucible. In the Soderberg method of aluminum reduction, a metal shell is set up over the surface of the molten bath and packed with the carbon anode material. The carbon anode materials (originally a paste-like composition) are baked by conductive heat from the electrolytic process. As the baked anode is consumed by the electrolytic process, the entire anode descends at a constant rate so as to keep a constant contact between the bath and anode, thus maintaining the flow of electric current. The anode mixture, then, is sufficiently hardened by the time it reaches the bath level of the pot. The anode baking is, thus, a continuous process with soft paste at the top of the anode and hardened paste at the bottom. The horizontal designation derives from the way that electric current is conveyed to the anode. Steel studs which carry the electric current are placed into the paste horizontally along the sides of the pot.

GENERATION OF PAH COMPOUNDS

The sources of airborne PAHs in the aluminum reduction process are constituents of the paste used in making anodes and cathodes: 1) Coal tar pitch, used as a binder for the aggregrates making up the anode and cathode paste, contains already condensed PAHs. When heated during paste mixing and electrolysis, these condensed PAHs may revolatize; 2) Coal, one of cathode paste aggregates, when heated during mixing and electrolysis, may form PAHs; 3) Petroleum coke, another aggregate, is calcined prior to use. It may contain condensed PAHs which may revolatilize during mixing and electroylsis. In relation to the total amount generated however, the primary source of the PAHs is the coal tar pitch. These PAHs once airborne may form small particles themselves or may cool and condense onto particulate matter.

SURVEY OF THE PLANT

A. Description of Exposed Work Groups

There are two production areas of the facility where worker exposure to PAH compounds is likely to occur: the potroom, in which are located the aluminum reduction cells, or pots, and the carbon plant where the anode and cathode pastes are prepared.

1. Potroom

Exposure to PAH compounds occurs primarily during pot servicing when the side doors must be raised to gain access. Exposure groups evaluated in this survey and a brief description of their duties are:

Pot Tender: attends the pot and makes control adjustments; determines need for and amount of materials addition, and inspects pot equipment; breaks crust occasionally.

Assistant Pot Tender: operates crust breaking machine so as to break crust formed over the molten bath, permitting alumina to enter bath.

Tapper: removes molten metal from pot by syphoning metal into crucible.

Assistant Tapper: assists the tapper in transfer of molten metal into crucible.

Stud Setter: operates stud setting and pulling machine which sets or removes studs into/from the anode. (The stud setting/pulling operation is normally considered part of the job activities of the anode tender. During this evaluation, exposure measurements were made of individuals (classified as anode tenders) who were performing only stud setting/pulling during the sampling period. For information purposes, therefore, a separate job grouping was used and measurement results reported separately.)

Anode Tender: responsible for unbolting, raising, reworking, or replacing flexes. Also positions side channels and does anode recycle work.

Crane Operator: operates overhead crane.

Other potential exposure groups of interest in the potroom which were not evaluated were the paste tender--who prepares the anode for paste addition, and the flex machine operator--who operates the flex raising machine.

2. Carbon Plant

Exposure to PAH compounds occurs during paste mixing. The paste compound is heated to approximately 150°C, so as to be homogenized. This temperais, however, much lower than that reached during the electrolytic process. (960°C).

Machine Operator: operates and controls grinding, screening, and conveying equipment to produce properly sized carbon materials.

Batch Operator: operates scales, conveyors, mixers, and associated equipment to produce paste to proper specification.

B. Description of Exposure Control Methods/Use of Personal Protective Equipment

At the time of this evaluation, all pots were locally exhausted to a dry scrubbing system. When the side doors were in place sealing the pot, visual observations indicated that the effectiveness of smoke and fume capture was, for the most part, satisfactory, although some smoke and fumes were seen to escape from the enclosure due to leaks. The leaks occur because of the less than tight fit at the interface of the side doors and the pot substructure, and at the interfaces of the side doors and the pot superstructure. Leaks also occur at the hooding/pot superstructure interface due possibly to warpage of various metal to metal seals. This situation arises because the hooding and superstructure must be removed to facilitate pot replacement, thus, precluding the use of permanent sealing techniques. Fugitive emmissions due to leakage rise to the potroom ceiling where they are exhausted to the atmosphere.

Engineering controls installed in the carbon plant were not operational during this evaluation. General ventilation (wall fans) were present and functioning, however.

Personal protective equipment used in the potroom included coveralls, head cover, safety glasses, and protective gloves. Additionally, some of the employees wore face scarfs. Dust respirators are available, but are not normally required except during actual servicing of the pot. Organic respirators are required when opening a pot, dumping a mixture, or similar procedure. Carbon plant workers wore coveralls, headcover, safety glasses, and gloves.

PRESENT APPLICABLE OCCUPATIONAL HEALTH STANDARDS/ THRESHOLD LIMIT VALUES

At the time of this report, there are no occupational health standards for those PAHs addressed in this report--Chrysene, Pyrene, Fluoranthene, Benz(a)Anthracene (BaA), Benzo(a)Pyrene (BaP). These substances are presently classified as a portion of those compounds contained in coal tar pitch volatiles (CTPV).[2] Generally speaking, CTPV refers to volatile matter emitted into the air when coal tar, coal tar pitch, or their products are heated.[2] Besides containing a large quantity of lower molecular weight polycyclic hydrocarbons, CTPV also contain <u>higher</u> <u>weight</u> polycyclic hydrocarbons, the aforementioned PAHs of which are in this group. Polycyclic hydrocarbons known to be carcinogenic are of this larger molecular type.[3] At the time of this report, three of the five PAHs evaluated have been shown to have varying <u>degrees</u> of carcinogenic activity in animals: BaP, strongly carcinogenic; BaA, carcinogenic; Chrysene, uncertain or weakly carcinogenic.[1] In 1967, the American Conference of Governmental Industrial Hygienists (ACGIH), through its Threshhold Limits Value (TLV) Committee, <u>recommended</u> an exposure limit for CTPV of 0.2 milligrams of benzene soluble components of CTPV per cubic meter of air (mg/M^3). This limit applies to a time weighted average (TWA) concentration for a normal 8 hour work day or 40 hour work week. Only <u>particulate</u> volatiles which are soluble in benzene are included in this level. The Committee stated that since no safe limit of exposure could be established for carcinogens, and due to the instability in the composition of volatiles from coal tar pitch, this exposure limit should minimize exposure to carcinogenic substances contained in the volatiles. The Occupational Safety and Health Administration (OSHA), at its creation in 1970, adopted this 1967 ACGIH recommendation as an occupational health standard. The current standard is 0.2 mg/M^3.[3,5]

The application of the standard for coal tar pitch volatiles to the aluminum reduction horizontal Soderberg process for the purpose of determining the degree of hazard to exposed workers must, however, be done with discretion. Certain job tasks in the Soderberg potroom necessary for pot operations give rise to the generation of non-volatile but still benzene soluble substances. Most evident is the stud setting, stud pulling, and crust breaking tasks which involve the use of compressed air equipment. Such equipment can exhaust oil mist--which contains, among other constituents, benzene soluble (but non-volatile) aliphatic compounds. These aliphatic compounds are not considered to present the same type of hazard as do the volatiles. Therefore, inclusion (usually unavoidable) of aliphatic contaminants in the determination of the benzene soluble fraction would tend to overstate the hazard potential arising from benzene soluble volatiles. Therefore, interpretation of benzene soluble data for this horizontal Soderberg process should be made with the aforementioned consideration in mind.

SAMPLING AND ANALYTICAL METHODS

Personal breathing zone and area samples were collected in the potroom and carbon plant for measurement of exposure to the benzene soluble fraction (BSF) of total particulate material (BSFTPM), to the BSF of vapor material (BSFVM), and to five PAHs--Chrysene, Pyrene, Fluoranthene, BaA, and BaP. Measurements were made for both particulate (PPAH) and vapor (VPAH) forms of these five PAHs. Measurements were also made for nuisance dust.

1. Benzene Soluble Fraction (BSF), PAH Compounds

   The sampling train consisted of a filter cassette housing a glass fiber filter and a 0.8 um pore size silver membrane filter to capture the particulate phase, followed by a glass tube containing porous polymer sorbent to capture the vapor phase. Sample flow rate was 1.5 liters per minute (lpm). The glass fiber and silver membrane filters and porous polymer sorbent were analyzed separately for BSF according to NIOSH P&CAM 217.[6] The portion of the sample extract remaining after the solubles analysis was analyzed for the five PAH compounds using reverse-phase high performance liquid chromatography according to NIOSH P&CAM 206.[7] (Addendum: Primarily as a result of the NIOSH evaluations conducted in the aluminum reduction industry--to characterize employee exposure to PAHs--the analysis of the porous polymer sorbent for the BSF--which would be indicative of exposure to BSFVM--has been discontinued by NIOSH. This was because porous polymer was found to have an inherently high and variable "background" content of benzene soluble material. (Average background for porous polymer: 0.05 milligrams of benzene soluble material per sample.) This made it difficult to determine the quantity of benzene soluble material--present on the porous polymer--which could be attributed solely to conditions of the work environment. Analyses of porous polymer for specific PAHs does continue. Excessive and variable "background" content on the porous polymer of the five PAHs have not been uncovered. (Background content on the porous polymer of the five PAHs, with few exceptions: less than the limit of detection of the analytical instrument)).

2. Nuisance Dust

Respirable nuisance dust was measured using a 10 millimeter cyclone in conjuction with a filter cassette containing a 0.8 um membrane (a copolymer of acrylonitrile and polyvinyl chloride) filter. Flow rate was 1.7 lpm. Total nuisance dust was measured using only the aforementioned filter type. Flow rates ranged from 1.5 to 2 lpm. Filters were weighed before and after sampling to ascertain weight change.[8]

RESULTS AND DISCUSSION

Table 1 shows the individual sample results for exposure to the BSF and to five specific PAH compounds. The upper value in each cell shows the value for the particulate analysis (BSFTPM, PPAH), while the lower value shows the value for the vapor analysis (BSFVM, VPAH). Table 2 is a summary of exposure to the BSF and PAH compounds by job title. (Addendum: For reasons indicated previously, the analysis of the porous polymer sorbent for the BSF is no longer conducted. Values for this analysis are, nevertheless, reported (BSFVM) in the interest of depicting exposures--to BSFVM--determined by state of the art analytical methods which existed at the time of this evaluation. Values listed for the BSFVM may not, however, be indicative of employee exposure).

Referring to Table 2, geometric mean* exposure to BSF of particulate material (collected on the glass fiber and silver membrane filter) ranged from 0.11 mg/M^3 for tapper and cranemen to 0.20 mg/M^3 for the anode tender. The main job activities of the pot tender, stud setter, and anode tender bring these groups into close proximity to usage of compressed air equipment---which may contribute aliphatic benzene soluble material to the exposure. Assuming this to be the case to some degree, exposure of these groups to the hazardous components of the BSF is probably less than the reported value. Exposure values for tapper and cranemen probably reflect actual exposures to the hazardous components, since compressed air equipment was not observed to be in the immediate area. Exposure measurements were obtained for two employees--the batch operator and the machine operator--in the carbon plant. Exposure values for BSF of particulate matter were 0.42 mg/M^3 and 0.44 mg/M^3 respectively. Compressed air equipment is used for opening and closing cylinders and loading chutes. Assuming that such equipment contributes some aliphatic benzene soluble material to the exposure, exposure of these employees to the hazardous components of the BSF is probably less than the reported value.

Analysis of the BSFTPM extract for the five PAH substances (PPAH) indicated the following geometric mean exposure concentration ranges for potroom work groups: Chrysene, 3.80 ug/M^3 to 6.40 ug/M^3; for BaA, 3.47 ug/M^3 to 4.87 ug/M^3; for BaP, 2.64 ug/M^3 to 3.84 ug/M^3. As can be seen, potroom work group exposure to chrysene was somewhat higher than exposure to BaA and BaP. Reported values for pyrene and fluoranthene for potroom workgroups are noticeably smaller than those of the other three PAH compounds. Because

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*Occupational environmental data has been shown by several investigators to follow a log-normal distribution. For this distribution, the measure of central tendency is the geometric mean.[9]

pyrene and fluoranthene are more volatile than are the other three PAH compounds, the possibility exists that quantities of pyrene and fluoranthene may have volatilized from the filter sample (thus not accounted for) between the time of sampling and analysis. Another possibility is that pyrene and fluoranthene may have evaporated during sample collection. (It has been reported that some PAHs are sufficiently volatile to evaporate during collection if long period sampling procedures at low flow rates are used.[1]) Accordingly, reported PPAH values for these two substances (are suspect and) may not represent true exposure values.

Geometric mean values for exposure to BSFVM and the vapor phase of the five PAHs (VPAH) are also shown in Table 2. With respect to VPAH values, geometric mean values for Chrysene, BaA, and B(a)P are near or below the limit of detection of the analytical instrument, in that they were derived from concentrations almost all of which were below the limit of detection of the analytical instrument. (Refer to Table 1 and note concentrations reported as less than ( ). Also refer to Table 2 footnote regarding statistical handling of this data). Significant levels of VPAHs pyrene and fluoranthene (compared to other three VPAHs) were detected. From an occupational health viewpoint, however, the significance of values from vapor analyses (in general) has yet to be determined. (In animal studies conducted by several investigators, purified PNA compounds, one such compound being BaP, have produced tumors of the tracheobronchiolar tree or lung parenchyma only when adsorbed onto particulates and injected below the larynx.[1]) At this time, vapor values are not incorporated in the CTPV standard. Measurements of the vaporous phase were made and results were obtained to provide an indication of worker exposure to presumably vapor volatiles and vaporous PAHs--both of which are not accounted for under the present CTPV standard.

Table 3 shows results of measurements of nuisance dust--respirable and total In most sets (respirable and total) for potroom workers the respirable dust value is considerably below that of the total dust. Interpreted slightly differently, a large proportion of the dust in the potroom appears to be non-respirable. Carbon plant employees (machine operator, batch operator) also have low concentrations of respirable dust. From an inhalation viewpoint, for dust exposure, the respirable fraction of total airborne nuisance dust is the fraction of concern. However, several measurements of total dust indicated exposure values exceeded the OSHA limit and/or TLV. (OSHA Standard[5]: Total Nuisance Dust--15 mg/M^3, Respirable Fraction--5 mg/M^3; TLV[4]: Total Nuisance Dust--10 mg/M^3, Respirable Fraction--5 mg/M^3).

CONCLUSIONS

Measurement of exposure of work groups in the potroom and carbon plant to five PAH compounds indicated, for most samples obtained, detectable concentrations of the particulate phase of all five PAHs and detectable concentrations of the vapor phase for two of the five PAHs.

For the particulate phase, exposure to Chrysene appears to be somewhat above that of exposure to BaA and BaP. Values obtained for pyrene and fluoranthene were markedly below values obtained for Chrysene, BaA and BaP. Possible reasons for this finding are loss of substance, due to volatility, between time of sample collection and analysis, and evaporation of substance during sample collection due to low flow rate. Therefore, reported values of pyrene and fluoranthene may be underestimated.

For the vapor phase, exposure to Chrysene, BaA and BaP, for most samples, was near or below the limit of detection of the analytical instrument. Exposure to pyrene and fluoranthene vapors are significantly above that of Chrysene, BaA, and BaP.

Measurement of nuisance dust, in selected jobs in the potroom and carbon plant, indicated that a large proportion of the dust is non-respirable. From occupational health standards/guidelines perspective, several measurements of total dust showed exposures to be above the OSHA limit and TLV.

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SIDE SECTION VIEW: HORIZONTAL STUD SODERBERG REDUCTION CELL

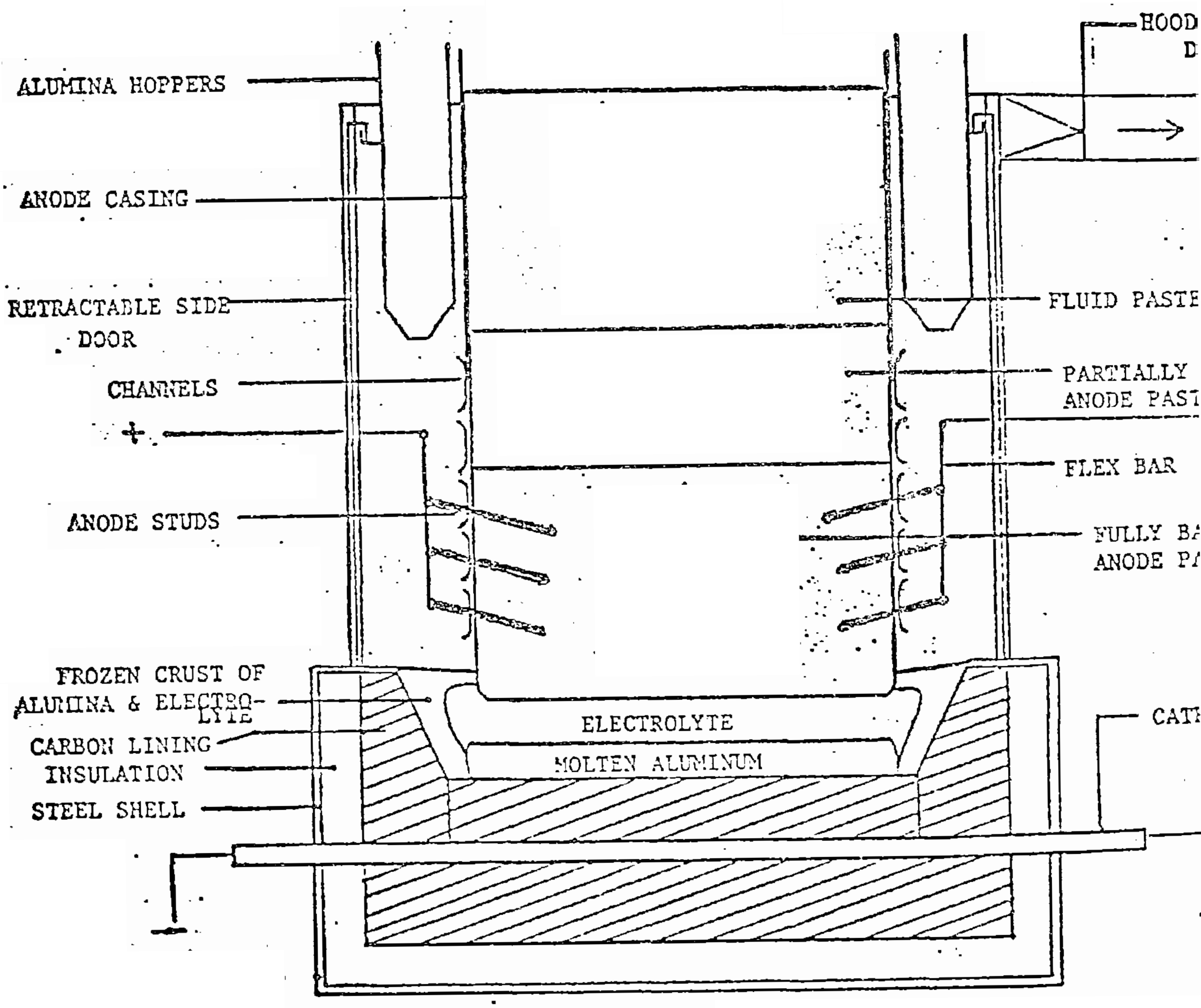

FIGURE I.

Table 1

Sampling/Exposure Data for Benzene Soluble Fraction,
Polynuclear Aromatic Hydrocarbons

Filter #	Date (1978)	Sample Time Min.	Air Volume M3	Job #	Description	Line-Sec-Rm.	Benzene Soluble Fraction mg/M3	Chrysene ug/M3	Pyrene ug/M3	Fluor-anthene ug/M3	Benz (a) Anthracen ug/M3	Benzo(Pyrene ug/M3
P1B	4/6	392	0.59	11	Pot Tender[1]	5-B	0.22 0.06	3.75 0.21	1.48 1.74	1.27 3.72	3.69 <0.14	3.02 <0.07
P5B	"	371	0.56	"	" "[1]	5-A	0.44 0.58	4.55 <0.83	1.75 4.38	1.67 2.46	4.58 <0.56	4.69 <0.28
P6B	"	372	0.56	"	" "	5-2	0.39 0.14	6.26 <0.28	1.67 7.60	2.98 4.61	4.87 <0.18	4.98 <0.10
P7B	"	371	0.56	"	" "	5-1	0.30 0.11	11.60 <0.28	2.61 7.47	3.26 6.43	11.80 <0.18	8.00 <0.10
AP2	"	405	0.58	"	" "	4-3	0.18 0.12	5.81 <0.18	2.04 3.98	1.50 3.37	6.03 <0.12	3.94 <0.06
AP3	"	406	0.61	"	" "	4-2	0.11 0.08	5.18 <0.21	<0.69 4.69	0.69 3.89	3.70 <0.13	3.22 <0.06
AP6	"	370	0.56	"	" "	4-A	0.33 0.22	2.33 <0.83	<1.39 1.57	0.45 2.79	2.04 <0.55	2.94 <0.28
P16B	4/7	428	0.64	"	" "	6	0.14 0.22	1.49 <0.28	<0.70 4.61	0.37 2.59	1.39 --	1.54 <0.10
P17B	"	423	0.63	"	" "	6-B	0.25 0.14	4.50 <0.28	2.25 7.59	1.75 5.13	5.43 <0.18	5.35 0.10
P18B	"	420	0.42	"	" "	6	0.08 0.17	5.27 <0.31	1.73 13.71	1.52 6.27	5.23 <0.21	4.22 <0.10
P20B	"	337	0.51	"	" "	3-4	<0.03 0.05	3.42 <0.17	0.95 5.65	0.95 1.59	2.94 <1.11	2.51 <0.55

Notes: Upper value in each cell represents particulate analysis
Lower value in each cell represents vapor analysis
1 - Assistant Pot Tender

Limits of Detection:
Benzene Solubles 0.02 mg/sample
Chrysene 3.0 ug/sample (1 ul injection)

Table 1

Filter #	Date (1978)	Sample Time Min.	Air Volume M3	Job #	Description	Line-Sec-Rm.	Benzene Soluble Fraction mg/M3	Chrysene ug/M3	Pyrene ug/M3	Fluor-anthene ug/M3	Benz (a) Anthracene ug/M3	Benzo(a) Pyrene ug/M3
P21B	4/7	392	0.59	11	Pot Tender	3-3	0.03 0.14	1.96 <0.82	0.58 10.49	0.35 4.83	1.60 ----	1.22 <0.10
AP10	"	438	0.66	"	" " 2	3-B	0.06 0.17	1.20 <0.42	<0.27 ---	0.15 0.59	0.82 <0.27	0.86 <0.14
AP16 1	"	408	0.61	"	" "	3	1.53 0.11	5.25 <0.28	5.85 3.14	6.09 1.55	6.51 0.18	4.44 <0.09
P2B	4/6	406	0.61	12	Tapper 3	5,6	0.22 0.11	6.89 <0.41	<1.38 2.88	1.96 1.68	7.33 <0.28	4.12 <0.13
P3B	"	360	0.54	"	"	5,6	0.11 0.08	4.94 <0.42	1.39 ---	1.01 1.93	4.89 <0.28	3.33 <0.14
P4B	"	357	0.53	"	"	5,6	0.08 0.08	1.90 <0.42	<0.35 1.61	0.45 1.67	1.52 <0.28	1.65 <0.14
AP5	"	410	0.62	"	"	4-3	0.14 0.08	8.74 <0.42	<1.39 5.65	0.73 7.70	5.68 <0.28	4.11 <0.14
P13B	4/7	446	0.67	"	"	5,6	0.06 0.03	1.65 <0.10	<0.70 3.71	0.42 1.96	2.70 <0.11	2.33 <0.06
AP11	"	441	0.66	"	" 3	3,4	0.19 0.14	4.39 <0.28	<1.39 13.47	0.85 7.58	5.03 <0.18	2.58 <0.10
AP13	"	447	0.67	"	"	4	0.06 0.14	5.14 <0.42	<0.70 13.44	1.04 9.76	6.02 <0.28	3.14 <0.14
AP4	4/6	441	0.66	15	Craneman	7,8	0.08 0.05	5.93 <0.16	<1.39 <0.28	0.58 <0.05	4.47 <0.10	4.51 0.05

Notes: Upper value in each cell represents particulate analysis

Lower value in each cell represents vapor analysis

1 - Sample was overloaded and is subject to inaccuracy. It is reported for sake of completeness.

2 - Assistant Pot Tender

3 - Assistant Tapper .

TABLE 1

Filter #	Date (1978)	Sample Time Min.	Air Volume M3	Job #	Description	Line-Sec-Rm.	Benzene Soluble Fraction mg/M3	Chrysene ug/M3	Pyrene ug/M3	Fluor-anthene ug/M3	Benz (a) Anthracene ug/M3	Benzo(a) Pyrene ug/M3
P14B	4/7	445	0.67	15	Craneman	6	0.14 <0.03	3.75 0.17	<0.70 3.71	0.42 1.96	2.70 <0.11	2.37 <0.06
P8B	4/6	358	0.54	17	Anode Tender	3	0.11 0.05	4.24 0.16	<1.39 7.20	0.51 2.71	3.11 <0.11	2.77 <0.05
P9B	"	355	0.53	"	" "	3	0.36 0.03	8.15 <0.17	<1.39 6.57	0.82 4.84	7.15 <0.11	4.56 <0.05
P10B	"	355	0.53	"	" "	3	0.19 0.11	8.32 <0.28	1.39 15.00	1.04 9.57	6.09 <0.18	4.73 <0.10
AP7/ AP21	"	356	0.53	"	" " 1		0.17 0.22	4.22 0.58	0.97 2.41	0.49 3.54	2.94 0.83	2.78 0.19
AP8	"	356	0.53	"	" " 1	3,4,5	0.31 0.11	5.93 <0.41	<0.70 3.32	0.75 4.46	3.76 <0.11	4.00 <0.14
P19B	4/7	403	0.60	"	" "	6,7	0.22 0.17	5.86 <0.28	0.70 13.12	1.04 8.51	4.16 <0.18	3.65 <0.10
AP12	"	298	0.45	"	" " 1	3,4	0.08 0.22	2.85 <0.42	<0.70 --	0.46 1.21	2.63 <0.28	1.71 <0.14
AP15	"	417	0.63	"	" " 1	3,4	0.22 0.06	5.03 <0.17	1.46 2.39	0.95 3.10	4.29 <0.11	2.57 <0.05
AP17	"	310	0147	21	Batch Operator		0.42 0.11	11.55 <0.83	5.39 10.88	5.92 13.83	31.81 <0.55	4.08 <0.28

Notes: Upper value in each cell represents particulate analysis
Lower value in each cell represents vapor analysis

TABLE 1

Filter #	Date (1978)	Sample Time Min.	Air Volume M3	Job #	Description	Line-Sec-Rm.	Benzene Soluble Fraction mg/M3	Chrysene ug/M3	Pyrene ug/M3	Fluor-anthene ug/M3	Benz (a) Anthracene ug/M3	Benzo(a) Pyrene ug/M3
AP18	4/7	343	0.51	"	Machine Operator		0.44 0.11	1.24 <0.41	0.82 3.09	0.79 1.45	2.74 <0.28	0.76 <0.14
P11B	4/6	187	0.28	40	Bkgd-Med Bldg		0.06 0.11	<0.17 <0.17	<0.28 0.37	<0.14 <0.05	<0.11 <0.11	<0.05 <0.05
AP19	4/7	373	0.56	"	Background		<0.03 0.14	<0.21 <0.28	<0.35 0.57	<0.07 0.21	<0.14 <0.18	<0.07 <0.10

Notes: Upper value in each cell represents particulate analysis
Lower value in each cell represents vapor analysis

TABLE 2

EXPOSURE SUMMARY: Benzene Soluble Fraction and Polynuclear Aromatic Hydrocarbons

Job Description	Benzene Solubles			Chrysene			Pyrene			Fluoranthene			BaA			BaP	
	No. Sam.	Geo. Mean mg/M³	Range mg/M³	No. Sam.	Geo. ug/M³ Mean	Range ug/M³	No. Sam.	Geo. ug/M³ Mean	Range ug/M³	No. Sam.	Geo. ug/M³ Mean	Range ug/M³	No. Sam.	Geo. ug/M³ Mean	Range ug/M³	No. Sam.	Ge ug/ Mea
Pot 1 Tender	14	0.16	0.01-1.53	14	3.80	1.20-11.60	14	1.08	0.13-5.85	14	1.07	0.15-6.09	14	3.51	0.82-11.80	14	3.1
	14	0.14	0.05-0.58	14	0.17	0.08-0.41	13	4.97	1.57-13.71	14	3.04	0.59-6.43	12	0.13	0.06-0.55	14	0.0
Tapper	7	0.11	0.06-0.22	7	4.14	1.65-8.74	7	0.52	0.17-1.39	7	0.82	0.42-1.96	7	4.25	1.52-7.33	7	2.9
	7	0.09	0.03-0.14	7	0.16	0.05-0.21	6	5.09	1.61-13.47	7	3.46	1.67-9.77	7	0.11	0.05-0.14	7	0.0
Craneman	2	0.11	0.08-0.14	2	4.71	3.75-5.93	2	0.49	0.35-0.70	2	0.49	0.42-0.58	2	3.47	2.70-4.47	2	3.2
	2	0.03	0.01-0.05	2	0.12	0.08-0.17	2	0.72	0.14-3.71	2	0.22	0.02-1.96	2	0.05	0.05-0.055	2	0.0
Stud Setter	4	0.17	0.08-0.31	4	4.35	2.85-5.93	4	0.65	0.35-1.46	4	0.63	0.46-0.95	4	3.34	2.63-4.29	4	2.6
	4	0.13	0.06-0.22	4	0.21	0.08-0.58	3	2.09	2.39-3.32	4	2.77	1.21-4.46	4	0.14	0.05-0.83	4	0.0
Anode 2 Tender	4	0.20	0.11-0.36	4	6.40	4.24-8.32	4	0.83	0.69-1.39	4	0.82	0.51-1.04	4	4.87	3.11-7.15	4	3.8
	4	0.07	0.03-0.17	4	0.13	0.08-0.16	4	9.82	6.57-15.00	4	5.71	2.71-9.57	4	0.07	0.05 0.09	4	0.0
Green Carbon	2	0.43	0.42-0.44	2	3.78	1.24-11.55	2	2.10	0.82-5.39	2	2.16	0.79-5.92	2	9.33	2.74-31.81	2	1.7
	2	0.11	0.11	2	0.29	0.20-0.41	2	5.80	3.09-10.88	2	4.48	1.45-13.83	2	0.20	0.14-0.27	2	0.1

Notes: Upper value in each cell represents particulate analysis
Lower value in each cell represents vapor analysis

°*The calculation of the Geometric Mean and establishment of the Range values required that a discrete value be*
to those Table 1 exposure concentrations reported as less than (<) a given concentration. (For these samples,
results indicated that concentrations were below the detection limit of the analytical instrument). The discre
assigned for these concentrations was *__one-half__* *of the reported less than (<) concentration.* 10

filter sample reported by laboratory to be overloaded

TABLE 3

SAMPLING/EXPOSURE DATA FOR NUISANCE DUST

Set #	Filter #	Date (1978)	Sample Time Min.	Air Volume M3	Job #	Description	Line-Sec-Rm.	Respirable Dust mg/M3	Total Dust mg/M3
A	2025(R) 1932(T)	4/6	344 344	0.69 0.58	11	Pot Tender	3-2	1.08	11.22
B	2003(R) 1987(T)	"	350 349	0.60 0.70	"	" "	3-4	1.50	3.38
C	1994(R) 2229(T)	4/6	329 329	0.49 0.46	"	" "	5-4	1.38	16.31
D	1979(R) 1885(T)	"	361 361	0.72 0.47	"	" "	6-3	0.56	6.77
E	1993(R) 2007(T)	4/7	425 424	0.72 0.85	" 17	Anode Tender	3,4	1.71	6.32
F	2042(R)	4/7	412	0.70	"	Anode Tender	3,4	0.64	---
G	1998(R) 2219(T)	4/7	407 407	0.69 0.57	"	" "	6,7	1.15	5.51
H	2030(R) 2224(T)	4/7	386 386	0.77 0.54	"	" "	6,7	0.48	10.86
I	1995(R)	4/7	343	0.58	21	Machine Operator		0.62	---
J	1989(R)	4/7	310	0.53	21	Batch Operato		0.55	---